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Mallotus philippensis (Lam.) Müll. Arg.: A comprehensive review on ethnomedicinal uses

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ABSTRACT

Despite advances in biomedical technology, many communities and local people are still dependent on natural and herbal medications. A large number of different ethnic groups like the Tharu, Kani, Garo and other local inhabitants thrive in the Indian subcontinent and other parts of the world. These indigenous people traditionally use *Mallotus philippensis* (Lam.) Müll. Arg. (Euphorbiaceae) for a variety of medicinal (ethno-veterinary and ethno-medicines), ritual and economic purposes. Therefore, the present article aims to assess how many various types of disorders are being treated by the ethnic groups using formulations prepared from this tree. In addition, we aim to identify the gaps in knowledge and recommend future investigations based upon them. The present analysis based on 83 articles indicated that different ethnic groups are utilising the tree to treat about 142 health ailments that can be broadly categorised into 11 types of disorders. Among these disorder categories, helminthic infestations, dermatological and digestive disorders are most frequently treated with formulations prepared from this tree. Among plant parts, fruits are the most exclusively used component followed by leaves and bark. The usage of fruits as an anthelminthic is widespread and highly cited for both animals and human beings. Thus, the tree can serve as a promising ethnomedicine to treat helminthic infestations, dermatological and digestive problems. Therefore, the cultivation of this medicinal plant should be encouraged in order to promote the conservation of this species.

Keywords: Kamala Tree; *Mallotus philippensis*; Medicinal Uses; Traditional Uses.

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SIGNIFICANCE STATEMENT

We analyzed the medicinal uses of the Kamala tree (*Mallotus philippensis*) among the ethnic groups of the Indian subcontinent. We found that the fruits of this tree are most frequently used for treating the helminthic infestations and skin disorders. This suggests that the fruits may have some active bio-chemicals that can be exploited for drug development. Further, relatively smaller number of studies as compared to ethnic diversity point towards a scope of further exploration of traditional uses of this particular tree. Future studies should investigate medical efficacy of active bio-chemical compounds isolated from the tree.

INTRODUCTION

Mallotus philippensis (Lam.) Müll. Arg. (Kamala tree), a member of Euphorbiaceae, is a perennial small to medium-sized tree, reaching more than 20 m in height. The medicinal potential of this tree finds frequent mention in ancient Indian literature like *Charaka Samhita, Sushruta Samhita* which is based on Ayurvedic system of medicines, *Indian Materia Medica* of Indian origin and *Indusyunic Medicine* in Pakistan (Khare 2007; Nadkarni 1976; Usmanghani et al. 1997). *Indusyunic Medicine* is a medicinal system evolved from ancient Unani and Ayurvedic system of medicines that also practice some newly adopted herbal drug formulations in Pakistan and adjacent regions (Usmanghani et al. 1997). According to Ayurveda, the fruits and leaves of this plant have anthelminthic, appetising, bitter, carminative, cooling, purgative and vulnerary properties (Ahmad et al. 2009; Gupta 2015). The plant is also said to be useful for bladder-stones, abdominal diseases, spleen enlargement, bronchitis, ulcers and tumours (Kirtikar and Basu 1935). Similarly, the Yunani medicinal system states that the red powder obtained from glands and hairs of the fruit have anthelmintic, bitter and styptic properties. It is also speculated to be useful for intestinal pain and skin diseases like scabies, ringworm and other skin disorders (Kirtikar and Basu 1935). Moreover, the powder is thought to stop bleeding, lower the blood glucose and relieve spasm (Khare 2007; Usmanghani et al. 1997). These documented medicinal properties have been scientifically tested and authenticated (Gangwar et al. 2014b; Rivière et al. 2010). A variety of important compounds such as cardenolides, flavonoids, tannins, fatty acids, chalcone and phloroglucinol derivatives have been isolated from this tree (Rivière et al. 2010). These active chemicals have found to possess interesting pharmacological activities like anti-cancer, anthelmintic, anti-fertility, antimicrobial and anti-inflammatory activity, which support the traditional medicinal uses of this particular tree (Gangwar et al. 2014b).

The medicinal properties of this species are implicated for various drug formulations that are available commercially. For example, the anthelmintic property makes fruit powder an essential constituent for Ayurvedic formulations like *Krimighatni Bati* and *Krimikuthar Rasa* that are important drugs used as anthelmintic. Similarly, *Roghan Kameela* and *Zimad Jarb* are the important drugs of Unani medicinal system, which are recommended for skin problems (Haque et al. 2015). In addition to these, *Itrifal Qanbil, Safuf Hikkah, Itrifal Deedan, Safuf Barg Hina Wala, Qurs Deedan and Marham Kharish Jadid* are some of the drug preparations of the *Indusyunic Medicines* in Pakistan that involve Kamala as one of the active ingredients (Usmanghani et al. 1997). Therefore, the tree is in high demand and quantities (0.155 tonnes/annum) are still required to meet requirements as per the Planning Commission, Government of India (Kala et al. 2006). Hence, the issue of its conservation also arises as to the demand increases.

A large number of people belonging to different ethnic groups and geographical areas still practice the traditional utilisation of this plant as an ethnomedicine for the treatment of health disorders. Various formulations prepared from this tree have been put into use for the treatment of stomach disorders, diarrhoea and dysentery, bronchitis, abdominal diseases, jaundice, urinary complications, parasitic affections and several other health disorders (Ahmad et al. 2009; Ahmed et al. 2017; Barkatullah

et al. 2015; Ghimire and Bastakoti 2009; Mahato and Chaudhary 2005; Nayak et al. 2004; Panda 2014; Uprety et al. 2011; Verma and Chauhan 2007). However, the pattern and frequency of treating various disorders and health ailments with formulations from this tree are not clear. Although the medicinal uses of this tree are prevalent in the Indian subcontinent and adjacent areas, these traditional uses have not been highlighted in previous review articles (Dhaker and Sharma 2014; Gangwar et al. 2014b; Sharma and Varma 2011; Tripathi et al. 2017). Therefore, in this review, we aim to answer the following questions: (1) How many disorders are being treated by formulations prepared from this tree? (2) Do these formulations vary within or between ethnic groups? (3) Which disorders are most frequently treated by this tree? (4) Among plant parts, which is most commonly used for the treatment of various health disorders? To accomplish this, we have surveyed the available databases along with unpublished grey literature including dissertations and theses. Yet, we do not pretend to be complete in our review, as collecting all the literature is a difficult task and some studies seemed to be beyond the scope of the present review, but surely, it will be useful for future research on the same tree.

General Botanical Information

The plant is known with more than 100 common names that vary with the geographical area, language and the medicinal system. These non-scientific medicinal names can be accessed at Royal Botanical Garden, Kew: Medicinal Plant Names Services. Botanically, Müller Argoviensis (Müller 1865) described the species as '*Mallotus philippinensis* (Lam.) Müll. Arg.' despite the original basionym epithet being cited as '*Croton philippensis*' by Lamarck and Poiret (Lamarck and Poiret 1786). However, the article 60 of the 'International Code of Nomenclature for algae, fungi, and plants' (Turland et al. 2018), states that the original spelling of a taxon must be retained and any typographical or orthographical error should be corrected. Therefore, we strongly recommend the use of corrected specific epithet as *"philippensis"* instead of *"philippinensis"*. Hence, we have retained the spelling as *"philippensis"* throughout the article and not "philippinensis" as used by many authors (Ahmed and Siddiqa 2013; Bandopadhyay et al. 1972; Gangwar et al. 2011, 2014a; Jabbar et al. 2006; Kulkarni et al. 2014; Lounasmaa et al. 1975; Panda 2014; Roberts et al. 1963; Saijo et al. 1989). Although the use of most of the synonyms has been substantially diminished in the modern literature, more than 20 botanical synonyms exist in taxonomic literature, which can be accessed at The Plant List.

The tree is morphologically distinguished by opposite granulose-glandular leaves with extrafloral nectaries on the upper surface. Inflorescences are usually terminal and fruits are trilobed dehiscent capsules. Fruits bear red coloured glandular hairs yielding a red powder known as 'Kamala' (Sierra et al. 2005) (Figure 1).

Kamala tree is widely distributed from Pakistan to South China and South Japan, throughout tropical Southeast Asia (Afghanistan, Bhutan, Cambodia, Indonesia, Sri Lanka, Thailand, Singapore and Myanmar) and Malaysia to East Australia and West Pacific (Solomon Islands) and the Philippines (Daikonya et al. 2004; Sierra et al. 2005). This tree is a common member in Sal (*Shorea robusta* Gaertn. f.), shrub and mixed forests throughout the tropical region

Figure 1. Morphological features of *Mallotus philippensis* tree (a) a twig with ovate leaves, (b) terminal inflorescence ripened into fruits and, (c) tri-locular fruits (capsules) bearing red glandular hairs.

of India but abundantly distributed in the forests of the Siwalik range of outer Himalayas (Figure 2). It is widespread in the districts of Himachal Pradesh but also occasionally in the drier parts such as Rajasthan, Madhya Pradesh and Uttar Pradesh and peninsular region of India (Khare 2007; Siva 2007).

The habitat of the tree includes scrubby vegetations, open rocky ground and under-storey of primary to secondary forests. It is growing well on various sites like disturbed sites, ridges, forest edges, steep slopes, road and riversides. It can manage to grow on variable soil types, like granite, limestone, sandstone, sandy clay, sandy loam soil, gravel and rock (Sierra et al. 2005).

METHODS

In order to get comprehensive information on this species, we have extensively explored available databases like Scopus (Mallotus AND phili*), Web of Science (Mallotus AND phili*), Google Scholar (allintitle: “Mallotus philippensis” OR “Mallotus philippinensis”), ScienceDirect (“Mallotus philippensis” OR “Mallotus philippinensis”), PubMed (Mallotus AND phili*). We got 245 articles from Scopus, 115 articles from Web of Science, 131 articles from Google Scholar, 313 articles from ScienceDirect, 54 articles from PubMed. Thus, in total, we got 858 articles through database searching and 19 additional records were found through other sources including published books, unpublished theses and dissertations. However, to maximize uniqueness in the collected information, all duplicate articles were discarded and only those articles were selected which described at least one traditional or local medicinal use. Thus, after discarding the duplicate, non-relevant and insignificant studies from the collected articles, finally, 83 articles were used for data extraction and analysis, which were related to ethnobiology or traditional knowledge (see Add File 1). Further, some studies have only included the medicinal use without citing the

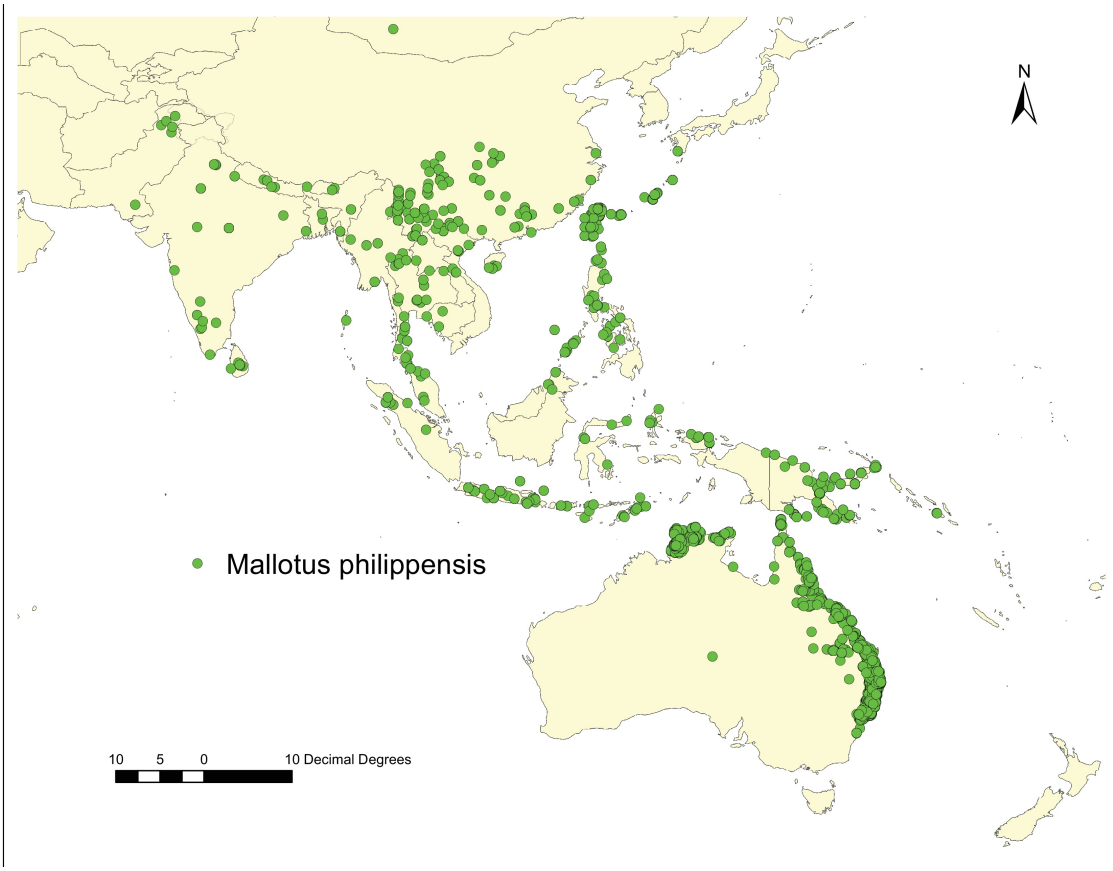

Figure 2. The distribution map of *Mallotus philippensis* species depicts the predominant distribution from Pakistan to Australia. The distribution data of species was taken from the Global Biodiversity Information Facility (GBIF) (https://www.gbif.org/species/5378605).

proper dosage and formulations, the inclusion of such studies have been discouraged while preparing the manuscript. Most of these studies were reported from the Indian subcontinent (comprising of India, Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka). Among these selected studies only about 35 studies have deposited a herbarium specimen of the species as indicated by voucher numbers. We have specifically looked for the plant part used, specific formulation and dosage used to treat different diseases (see Add File 1). After acquiring all the information from the articles, the diseases were classified primarily depending on the type of body system affected. However, some diseases were classified based on the source of infection because these diseases tended to affect more than one body system. For quantification and assessing the consensus of the traditional medicinal uses, we considered the actual number of informants that cited a particular use in a particular study. Unfortunately, some studies have not provided the actual number of informants and for such studies, we have considered the number of informants as one. A vote count approach was chosen to assess the consensus of the medicinal use of this tree. The data was compiled using MS Excel and R programming language (R Core Team 2018) was used for graphical representation as figures.

Socio-Economic Importance

Natural dyes play an important role in the livelihood of local and rural people. For example, in Bhutan, rural people cultivate dye-yielding plants, prepare dye and earn money by selling the dye (Tshering 1996). The glands of ripened fruits of this tree yield a yellow to orange-red coloured dye, called as the Kamala dye (Panda et al. 2018; Rao and Seshadri 1947; Sierra et al. 2005). Fresh fruits are known to yield about 1.4 - 3.7% red powder containing pigment Rottlerin (Siva 2007). A method of extraction of the dye from the fruit-pericarp of the tree has been already described and patented (Maeda et al. 2009). The red dye obtained from the tree is frequently used for preparing traditional Bhutanese fabrics and colouring silk clothes (Tshering 1996). This dye along with a mordant (Alum) is used for dyeing silk and wool clothes (Rao and Seshadri 1947; Siva 2007). This dye is believed to be superior for woollen and silk fabrics (Gaur 2009).

The Kamala powder is also used as a dyestuff in food (Gaur 2009; Rao and Seshadri 1947). The active compounds of the dye, rottlerin and its penta-potassium derivatives are employed for colouring foodstuffs, juices and other beverages (Caius 2012). Apart from colouring soaps, oils and ice creams (Rao and Seshadri 1947), it is also employed as an antioxidant for ghee (clarified butter) and vegetable oils (Rao and Seshadri 1947; Siva 2007). The powdered dye is widely used in perfume, leather and textile industry. The dyestuff finds applications in paintings and decorating wooden crafts especially by *Bokshas* (an indigenous community found in the Western region of Himalayas) (Gaur 2009). In Chromotherapy, the dye is used for body adornment (Gaur 2009). In addition to fruit powder, seed oil is used in painting and varnishing works (Caius 2012). The oil is also used as a substitute for Tung oil (*Vernicia* Lour., Euphorbiaceae) in the formulation of rapid drying paints, varnishes, hair fixers and ointments (Sierra et al. 2005).

The wood of the tree is a good source of fuel for household purposes (Dhanai et al. 2015; Samant et al. 2000; Sher et al. 2011; Zabihullah et al. 2006). In Australia, the wood is used for brush ware, flooring, and packing cases (Siva 2007). The wood is suitable for rafters, tool handles, matchboxes, and house-posts (Sierra et al. 2005). The leaves of the tree are good fodder sources and livestock fed on the leaves (Dhanai et al. 2015; Habib et al. 2016; Samant et al. 2000; Sierra et al. 2005). Thus, the tree has several important non-medicinal uses, which are very important from a socio-economic point of view.

RESULTS

Almost all the parts of the Kamala tree, are used for medicinal purposes either in single or combinatorial formulations by different tribal ethnic groups of the Indian subcontinent. For example, a mixture of roots, leaves and fruits of the tree with honey provides relief against biting of honeybee, scorpion and snakes (Adhikari et al. 2010; Subrahmanya 2012). On the other hand, fruit powder alone is effective against several worms (Akhtar and Ahmad 1992; Davis et al. 1995; Dikshit and Lalit 1970; Qasim et al. 2016; Usmanghani et al. 1997). Moreover, the tree has potential to cure health disorders ranging from most common ailments such as cough, cold and fever (Chassagne et al. 2016) to life-threatening diseases like cancer (Khan et al. 2013;

Kulkarni et al. 2014; Tanaka et al. 2008). Various components of the plant (in powdered form) are known to cure common skin ailments (Reddy 1995). For example, a preparation made by mixing the powdered bark and leaf in butter is applied on sores and boils in Solan, Himachal Pradesh (Verma and Chauhan 2007) and for skin diseases in Azad Jammu and Kashmir in Pakistan (Rashid et al. 2015). Similarly, the local communities of Cuddappa district of Andhra Pradesh (Reddy 1996) and Bajaur Agency, Pakistan (Aziz et al. 2017), use plant powder for skin diseases and wound healing, respectively.

Various formulations prepared from this tree are most frequently used for helminthic infestations, dermatological and digestive disorders (Figure 3). These formulations not only vary among ethnic groups but also vary for the same ethnic group and same disorder (see Add File 1). Among the plant parts, fruit is the most common ingredient for formulations used to treat various health disorders followed by leaves and bark of the tree (Figure 4).

Fruits and leaves together constitute more than 60% of formulations used to treat various disorders. Further, the use of this tree for the treatment of helminthic infestations is most frequently cited (63.7%), though, digestive disorders had a greater number of articles (27.46%) as compared to helminthic infestations (22.54%). The use of different plant parts also varied with the disease category. For example, helminthic infestations are frequently treated with fruits and whole plant whereas dermatological and

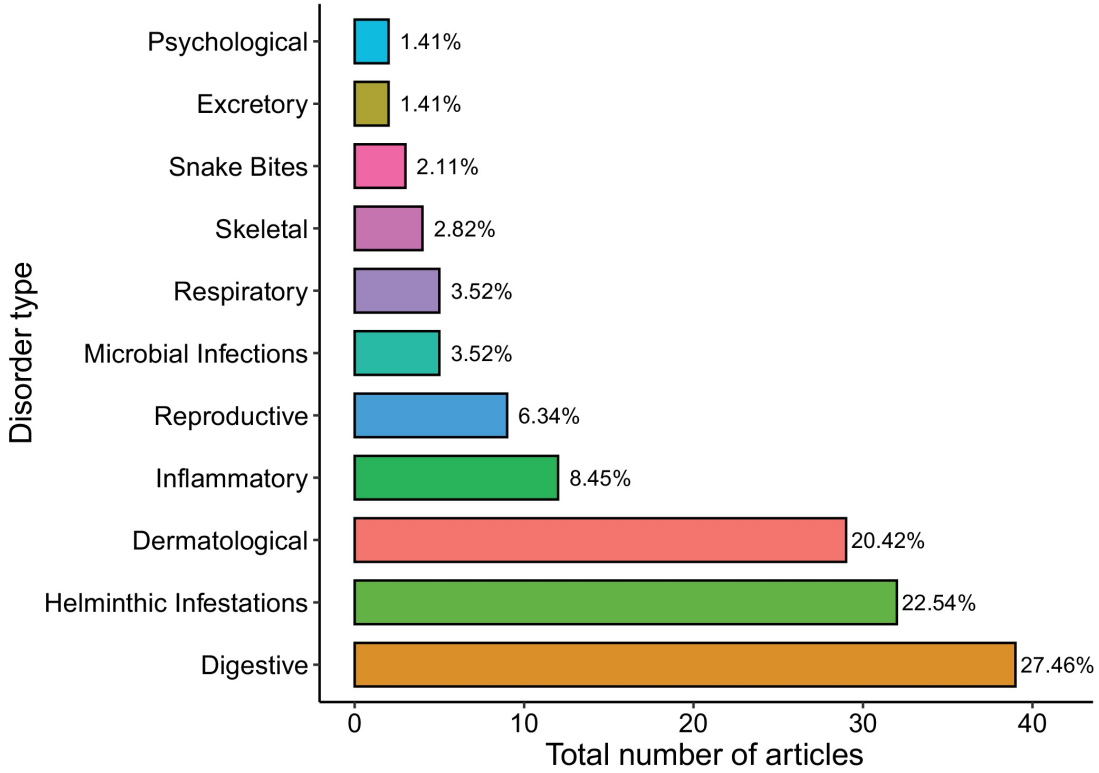

Figure 3. Bar diagram showing distribution of the articles (n = 142) according to cited their disorder categories.

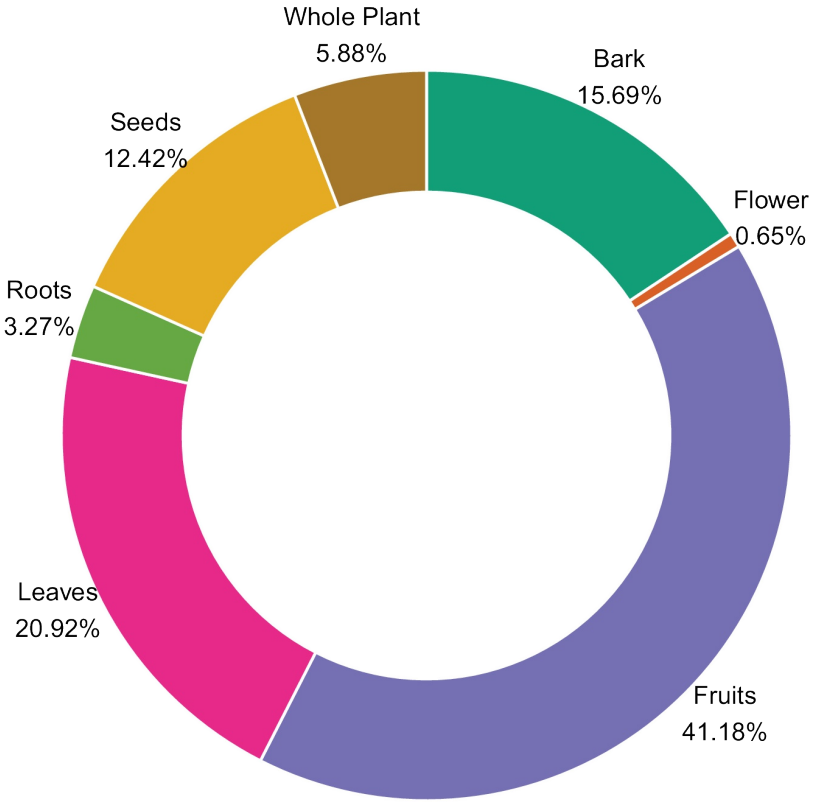

Figure 4. The frequency of plant parts used for the treatment of various disorders (n = 153).

digestive disorders are treated with bark, leaves and seeds (Figure 5). Furthermore, the Indian sub-continent is very diverse in culturally and linguistically delineated ethnic groups (Figure 6). However, the reported studies about the traditional uses among ethnic groups are relatively scarce, suggesting that the traditional uses of this particular are not be fully documented and there is a scope of further explorations. Next, we have discussed the major medicinal usage of different formulations prepared from this plant.

Dermatological disorders

Skin diseases like leprosy, itching, boils, scabies, ringworms, cuts and infections are often treated by directly applying formulations prepared from the various components of the tree. About 20% of total articles mentioned the use of this tree for skin-related disorders and 15% of total informants suggested its use for the same purpose. The fruit powder of this plant is often employed for various skin diseases such as scabies, herpes, ringworm, freckles, pityriasis and several bacterial caused skin problems (Khare 2007; Usmanghani et al. 1997).

The local people from Azad Jammu and Kashmir, Pakistan (Rashid et al. 2015) and the Solan district of Himachal Pradesh, India (Verma and Chauhan 2007) apply a paste (prepared by mixing powder of bark and leaves with butter) externally on skin affected with sores and boils. Similarly, the bark paste alone is used to stop bleeding from wounds by the Bhilla people of Maharashtra (Kamble et al. 2010) while the

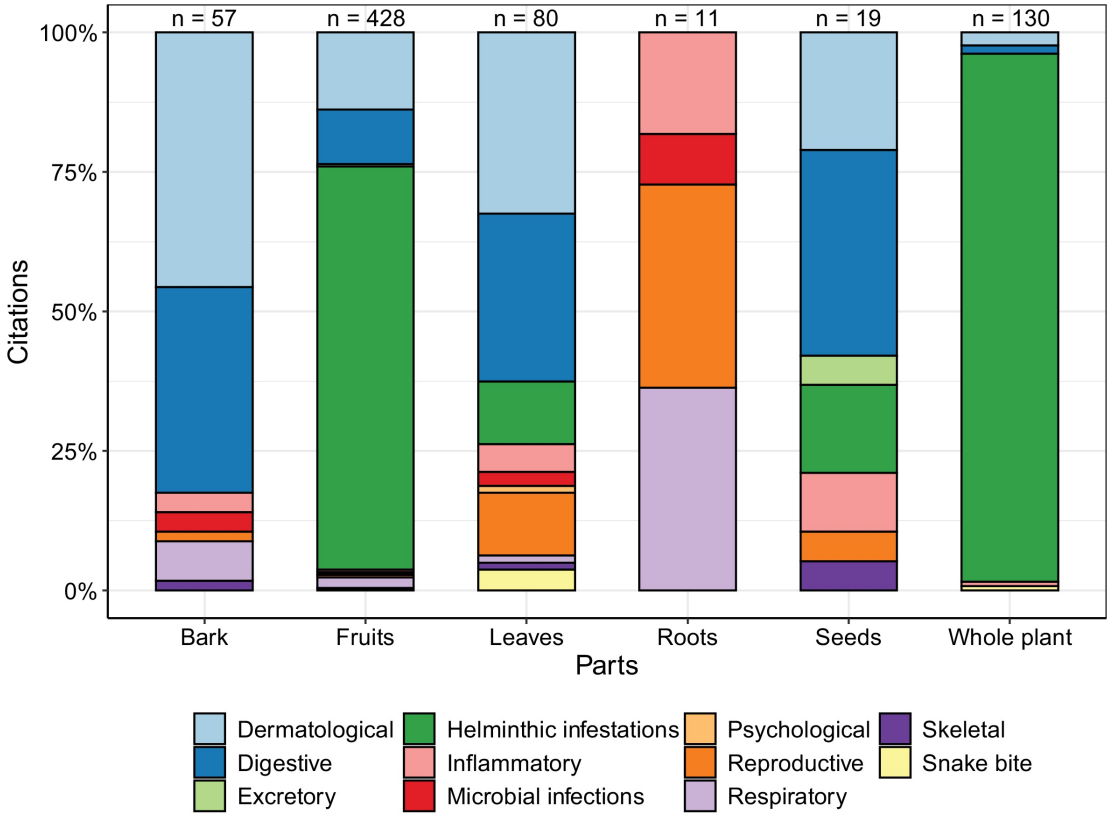

Figure 5. The stacked bar showing the usage of each plant part to different categories of the disorders. The total number of citations of particular plant parts are given at the top of each bar.

local people from Satpura hills use the bark paste to treat skin burns (Kosalge and Fursule 2009). Fruits are styptic and fruit hairs are used for scabies and cutaneous affections (Khare 2007; Siva 2007). The fruit powder mixing with a suitable oil is used for ringworms, skin irritation and wounds (Usmanghani et al. 1997). For example, the red powder from fruit pericarp mixed with mustard oil is applied externally twice a day for skin diseases and burns by the local people of Arghakhanchi district of Nepal (Panthi and Singh 2013) and Una district of Himachal Pradesh, India, respectively (Rana et al. 2017). On the other hand, the same powder is mixed with coconut oil and used for skin diseases and blisters of the ear in Rewa district of Madhya Pradesh, India (Shukla et al. 2010). Similarly, a paste prepared by mixing fruit powder with ghee (clarified butter) is externally applied on boils and blisters by the local people of Kalahandi district of Orissa (Nayak et al. 2004) and sub-Himalayan region of Uttarakhand (Sharma et al. 2013). Moreover, the red colour powder is also used as an ointment for ringworm, freckles and pityriasis (a type of skin rash) and also applied over syphilitic ulcers (Usmanghani et al. 1997). The local people of the North-West Frontier Province of Pakistan (Abbasi et al. 2010b) and the Tharu community of the Uttarakhand, India (Sharma et al. 2014) directly apply the juice prepared from the crushed leaves to cure skin diseases such as boils, ringworms, cuts and wounds. On the other hand, the people from adjacent Chirang Forest Reserve of Assam, India take a cold decoction of leaves for similar problems (Panda et al. 2018). In Bhopal, India, the external application of a

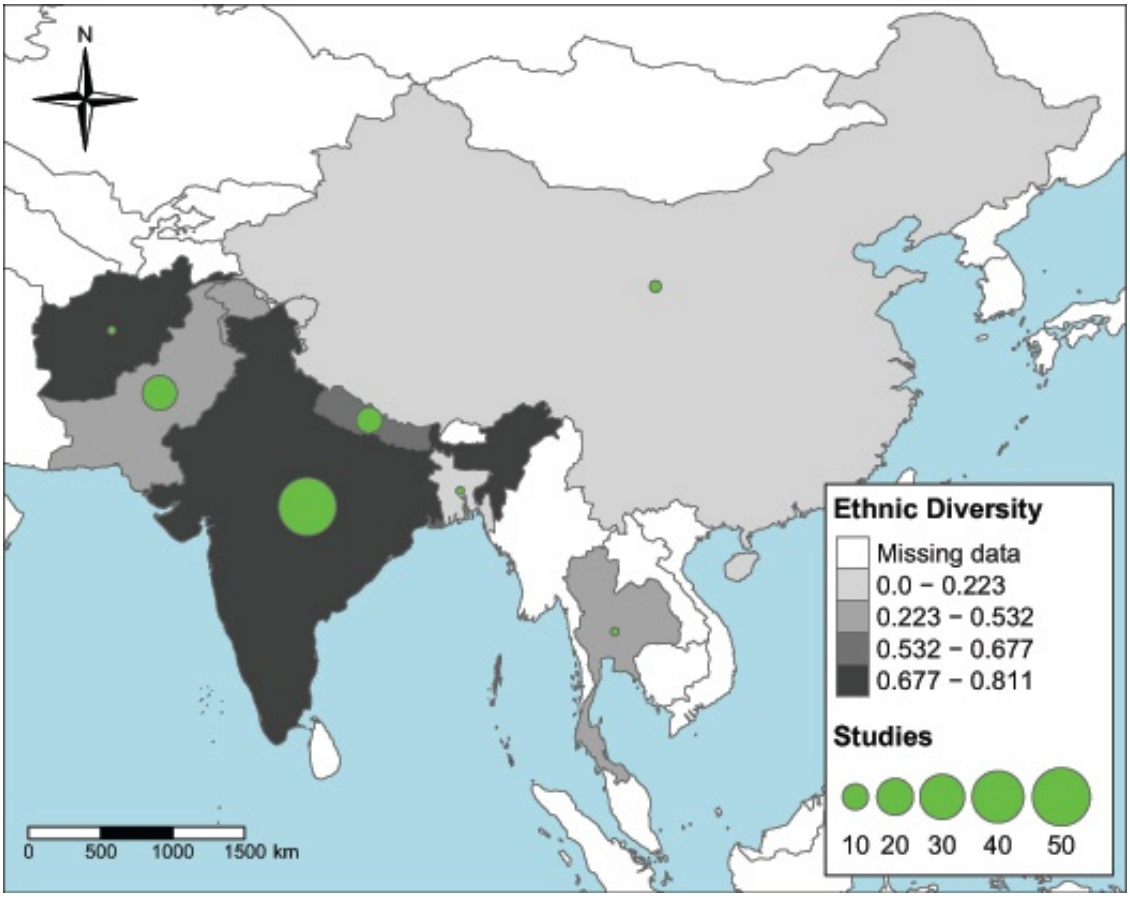

Figure 6. The total number of studies reporting the traditional uses of *Mallotus philippensis* is relatively scarce as compared to the ethnic diversity (based on Fearon 2003) of the countries in which plant is distributed.

mixture prepared from seed powder of Kamala mixed with sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil provides relief against dermatitis (Khan and Chaghtai 1982) while in Andhra Pradesh a paste prepared from the whole plant or any part in powdered form is applied externally for skin diseases (Reddy 1995, 1996). The fruit powder from pericarp is taken internally with other suitable drugs for relieving leprous affections in Pakistan (Usmanghani et al. 1997) and Madhya Pradesh state of India (Gupta et al. 2018). The wound injuries and skin infections of pigs and other domestic animals are cured by external application of seed powder in Sikkim Himalayas (Bharati and Sharma 2010, Bharati and Sharma 2012). A paste prepared from ground fruits and rhizome of *Curcuma longa* L. is known to stop bleeding when applied on wounds (Bhatia et al. 2014). In Una and Hamirpur districts of Himachal Pradesh, local people use fruit oil for skin diseases. In the same region, a poultice prepared from all the plant parts with rice-water (the thick liquid left after boiling rice) is used for ulcers, sores and swellings (Chand et al. 2016).

Digestive disorders

According to Ayurveda fruits are useful for abdominal diseases (Ahmad et al. 2009) and abdominal pain is still treated by taking a decoction of bark in the Bay island of Andaman and Nicobar Islands (Das et al. 2006) and Uttar Pradesh (Singh and Singh 2009) whereas a cold decoction of leaves is taken by the local people of the Chirang

Reserve Forest in Northeast India (Panda et al. 2018). Moreover, Raute people of Nepal treat indigestion by taking 3 teaspoons of bark juice four times a day (Manandhar 1998). Constipation is often treated by taking fruits either as an extract or red powder of pericarp in Western Himalayan region, Orissa and Andhra Pradesh of India (Chand et al. 2016; Malik et al. 2015; Nayak et al. 2004; Reddy 1995). However, tribal inhabitants of Abbottabad district, Pakistan use dried seed powder mixed with curd for constipation (Abbasi et al. 2010a). Fruits are useful for the diabetic people and a decoction of fruits (prepared by boiling few fruits of *Mallotus philippensis* (Lam.) Müll. Arg. and seeds of *Syzygium cuminii* (L.) Skeels in about 200 ml of cow's milk) is taken twice a day for a period of about one month to treat diabetes (Khare 2007; Maruthupandian et al. 2011; Seethapathy et al. 2018). On the other hand, the Taungya people of Uttar Pradesh take a teaspoon of seed powder (once a day) for lowering blood glucose levels and purgation (Poonam and Singh 2009).

An indigenous community, the Tharus is a culturally and linguistically diverse ethnic group, that lives along the Indo-Nepal border in the region known as Terai. These local people frequently take 3-4 teaspoon of bark juice thrice a day for diarrhoea and dysentery in Nawalparasi, Rupandehi and Palpa districts and the Western Terai region of Nepal (Acharya and Acharya 2010; Ghimire and Bastakoti 2009; Mahato and Chaudhary 2005; Taylor et al. 1996b). On the other hand, local people of Malakand Pass Hills, Pakistan (Barkatullah et al. 2015) and Kalahandi district of Orissa (Nayak et al. 2004) take fruit preparations orally to treat diarrhoea. Many local communities such as nomadic Gujjars, Tharu and Bhoxa treat Jaundice by taking small tablets prepared from seed powder with cold water in Uttarakhand and Himachal Pradesh states of India (Sharma et al. 2012a; Verma and Chauhan 2007).

Stomach disorders are treated by the application of various components and formulations. Stem bark and leaves are used by the local people of hilly areas in Tamil Nadu for stomach pain (Seethapathy et al. 2018) or bark juice can also be taken directly. A decoction of stem-bark and leaf of the tree (locally called as 'Kutthu Senkalai') with stem bark of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr., the root bark of *Phyllanthus emblica* L. and fruits of *Phoenix dactylifera* L. are used to cure stomach pain by Kani people in Tirunelveli hills of Tamil Nadu, India (Ayyanar and Ignacimuthu 2005). On the other hand, local people of Western Nepal either take seed decoction or a paste prepared from powder of this plant mixed with roots of *Saccharum spontaneum* L., fruit powder/paste of *Piper longum* L., root juice of *Tinospora cordifolia* (Willd.) Miers and root juice of *Cheilanthes dalhousiae* Hook. is used for stomach ache (Uprety et al. 2011). Red fruit powder mixed with water or bark juice is also taken for gastric disorders (Das et al. 2006; Ghimire and Bastakoti 2009). Fruits are generally considered as purgatives by the local people of Kot Manzaray Baba Valley (Zabihullah et al. 2006) Margala Hills National Park, Islamabad (Ahmad et al. 2009) and Chagharzai Valley of Pakistan (Sher et al. 2011). The Palliyar people of Sirumalai hills, in Tamil Nadu boil few fruits of *Mallotus philippensis* (Lam.) Müll. Arg. with seeds of *Syzygium cuminii* (L.) Skeels in 200 ml of cow's milk. The decoction so obtained is taken twice a day for a period of about one month to treat diabetes (Maruthupandian et al. 2011). Leaves are considered carminative by local people of Mount Abu region of

Rajasthan (Gupta 2015) and Azad Jammu and Kashmir region of Pakistan (Rashid et al. 2015) whereas local people of Kalahandi district in Orissa consider them as appetizers (Nayak et al. 2004).

Excretory disorders

The local people of Kalahandi district and Simlipal Biosphere reserve of Odisha, India take orally a paste prepared from fruits or fruits and seeds both to treat urinary infections (Nayak et al. 2004; Panda 2014).

Helminthic infestations

The anthelmintic potential of Kamala fruits finds frequent mention in ancient literature of India and Pakistan (Khare 2007; Nadkarni 1976; Usmanghani et al. 1997). Kamala, the powdered glandular hairs of fruits have anthelmintic properties (Ahmad et al. 2009; Ahmed and Siddiqa 2013; Malik et al. 2015; Nadkarni 1976; Qasim et al. 2016; Sher et al. 2011; Sierra et al. 2005; Siva 2007; Usmanghani et al. 1997) and it expels intestinal worms through purgation either dead or alive. Various formulations prepared from the fruits of this tree are used against several gastrointestinal worms such as tapeworms (Akhtar and Ahmad 1992; Chand et al. 2016), liver flukes, lungworms (Davis et al. 1995), threadworms, roundworms and hookworms (Das et al. 2006). This property makes fruit powder an essential constituent for Ayurvedic formulations like *Krimighatni Bati* and *Krimikuthar Rasa* that are important drugs used as anthelmintic. Both of these products are manufactured by Ayurveda based companies like Baidyanath (Kolkata, India) and Zandu (Mumbai, India).

The International veterinary community recognises the fruits of *Mallotus philippensis* (Lam.) Müll. Arg. as an effective treatment for tapeworms in goats, dogs, cats and other animals (Akhtar and Ahmad 1992). The *Pashtun Kuchi* nomads of Afghanistan employ fruit powder for the treatment of small ruminants infected with liver flukes, gastrointestinal worms, lungworms, internal parasites, and their toxins (Davis et al. 1995). Similarly, fruit powder is also given for curing Barber's pole worm (*Haemonchus contortus* (Rudolphi, 1803) Cobb, 1898) infestation in small ruminants of Punjab, Pakistan (Qasim et al. 2016) and for helminthic infestation of camels in Kathua district of Jammu & Kashmir, India (Sharma and Manhas 2015). On the other hand, seeds are given to pigs in Sikkim Himalayas for intestinal worms (Bharati and Sharma 2012) while seed powder with curd or lassi (buttermilk) is given to animals in Hamirpur district of Himachal Pradesh (Bhatti et al. 2017) to kill intestinal worms.

Fruit powder mixed with curd is a frequent treatment for common ailments of animals such as an infestation of internal parasites (Bhatia et al. 2014; Sharma et al. 2012b). However, the dosage and formulations vary not only within the same regional areas but also in different localities of the Indian subcontinent. For example, more than 10 types of preparations and dosage administration are reported only from Sahiwal district of Punjab, Pakistan alone (Hussain et al. 2008). Doses are prepared by mixing 4 drams (1 dram = 1.77 g approx.) of fruit powder with 0.5 L of milk (or milk whey) or curd or mustard oil and administered per os. Fruit powder is also administered with milk (10 g fruit powder with 0.5 L of milk) or water (50 g fruit powder with 0.5 L of water) or with jaggery (10 g fruit powder mixed with jaggery). In another dosage preparation, 10 g of each powdered fruits of *Mallotus philippensis* (Lam.) Müll. Arg. and *Tamarix aphylla* (L.) H. Karst. and

seeds of *Brassica campestris* L. mixed with 0.5 L of mustard oil and 0.5 kg of curd and administered per os. In Cholistan desert of Pakistan, about 100–200 g of fruits soaked in 500 g of yoghurt are given to livestock for the treatment of parasitic diseases (Farooq et al. 2008). Moreover, the herdsmen of Muzaffargarh district of Punjab, Pakistan give fruits with jaggery (Jabbar et al. 2006) while in Hassan district of Karnataka (India), it is given along with wheat flour (Kumar and Nagayya 2017) for curing intestinal worms in ruminants and other livestock animals.

The anthelminthic use of this tree for human beings is relatively less frequent as compared to animals. Several ethnic groups and local communities still traditionally utilise fruits as purgative and anthelmintic agents for human beings in India as well as Pakistan (Jabbar et al. 2006; Khare 2007; Sher et al. 2011). A fruit decoction in Purulia district of West Bengal (Chakraborty and Bhattacharjee 2006) and an extract prepared by boiling the fruits with common salt in Dehradun area of Uttarakhand is used as an anthelmintic (Jain and Puri 1984). The local inhabitants of Western Himalayan region (Malik et al. 2015; Rao et al. 2015; Rashid et al. 2015) and Bay Island of Andaman and Nicobar Islands (Das et al. 2006) eat fruits orally for killing the gastro-intestinal worms such as threadworms, hookworms and roundworms. As far as dosage is considered, in India, a single dose of 1 g Kamala powder for children ≤ 5 years and 2 g for children ≥ 5 years has been reported to eradicate 96% of the dwarf tapeworm (*Hymenolepis nana* (Bilharz, 1851) Ransom, 1901) infection (Dikshit and Lalit 1970). Although most of the studies employ fruits as the most common treatment of helminthic infestations, there are few reports where other parts of the tree were also used. For example, tribal inhabitants of Abbottabad district in Pakistan uses dried seed powder mixed with curd for killing intestinal worms and constipation (Abbasi et al. 2010a). Similarly, the whole plant is used for tapeworms by the Tharus of Nepal (Ghimire and Bastakoti 2009) and the local people of Rawalpindi district of Pakistan (Saqib et al. 2014). The Malamalasar people of Kerala use a decoction of flowers for tapeworms (Yesodharan and Sujana 2007). Thus, the above discussion shows that the fruits are almost exclusively used for the anthelmintic purpose and about 380 informants from 15 studies have reported the use of the tree as anthelmintic.

Inflammatory disorders

Some fevers developed due to inflammation such as the puerperal fever are treated by taking either whole plant powder (Ghimire and Bastakoti 2009) or tablets prepared from a paste of leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., the bark of *Cinnamomum verum* J. Presl, camphor, the fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., the fruit of *Ficus scandens* Lam., the clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, the fruit of *Amomum subulatum* Roxb., the fruit of *Amomum aromaticum* Roxb., the fruit of *Piper longum* L., the rhizome of *Curcuma zedoaria* Roxb., top of the stem with the leaf of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., the rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal (Ahmed et al. 2017). However, local people from Limu mountains of Hainan Island (China) treat headache by external application of toasted leaves of the tree (Zheng et al. 2013). Almost all the parts of the tree can be used for the treatment of

rheumatism. For example, to get relief from rheumatism bark decoction is taken internally in Kerala and Karnataka region of India (Subrahmanya 2012) while leaf decoction is used in Solan district of Himachal Pradesh, India (Verma and Chauhan 2007). In Western Ghats of Tamil Nadu, a paste is prepared by mixing an equal amount of leaves and tender fruits in honey. This paste is taken twice a day for 13 days to get relief from rheumatism (Sutha et al. 2010). Among the Mundas of Chota Nagpur (India), well-ground roots are rubbed on the rheumatic joints (Kirtikar and Basu 1935) while in Orrisa (= Odisha) local people also use root-bark for arthritis and rheumatism (Biswas 2012). In Bhopal, India, the external application of a mixture prepared from seed powder of Kamala mixed with sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil provides relief in rheumatic joints and dermatitis when applied externally (Khan and Chaghtai 1982) whereas only seed paste is externally applied for rheumatism in Andhra Pradesh (Reddy 1995). In addition to these, bark juice is taken for meningitis in Nepal (Ghimire and Bastakoti 2009) and fruit decoction is used for enlarged spleen in children of West Bengal (Chakraborty and Bhattacharjee 2006).

Microbial infections

Limited information is available about the traditional use of this plant for microbial infections. Bark has antibacterial and antiviral properties (Taylor et al. 1996a) and used against microbial infections. In Southern parts of India, oil prepared from leaves is applied on the head for cold and running noses (Subrahmanya 2012). Local inhabitants of Solan, Himachal Pradesh believes that roots of this tree can treat poliomyelitis and they traditionally use to tie small roots around the neck of polio-affected children (Verma and Chauhan 2007).

Psychological disorders

Fruits have cathartic properties (Khare 2007; Usmanghani et al. 1997). Similarly, leaf paste prepared with eggs of the hen is applied on eyes for treating dizziness among the ethnic groups (Korku tribe) in Amravati district of Maharashtra, India (Jagtap et al. 2006).

Reproductive disorders

The decoction of stem-bark and leaf of the tree (locally called as 'Kutthu Senkalai') with stem bark of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr., the root bark of *Phyllanthus emblica* L. and fruits of *Phoenix dactylifera* L. are used to cure hydrocele and stomach pain by Kani people in Tirunelveli hills of Tamil Nadu, India (Ayyanar and Ignacimuthu 2005). The Reang people of Tripura state of India treat leucorrhoea by eating curry of leaf buds (Shil et al. 2014) while the local Tai Yai people of Thailand eat the boiled roots for treating leucorrhoea (Khuankaew et al. 2014). Menstrual disorders are treated by taking internally fruit paste or a paste of fruits and seeds both by the local inhabitants in Odisha (Nayak et al. 2004; Panda 2014). The juice is prepared by crushing leaves of *Mallotus philippensis* (Lam.) Müll. Arg., leaves of *Rungia pectinata* (L.) Nees. and fruits of *Piper longum* L. About half cup of this juice is taken for 4-5 days to regularize un-periodic menstruation by local people of Nasik district of Maharashtra (Patil and Patil 2004).

Respiratory disorders

The local Tai Yai people of Thailand take orally the boiled roots for treating allergic asthma (Khuankaew et al. 2014). The local people of Nepal treat bronchitis by drinking bark juice of the tree (Acharya and Acharya 2010; Ghimire and Bastakoti 2009). Local tribal-healers of Madhya Pradesh employ fruits for tuberculosis, chest complaints, leprosy and wounds (Gupta et al. 2018). Local communities of Shahjahanpur, Uttar Pradesh take leaf powder for cough (Sharma et al. 2010).

Skeletal disorders

A mixture of bark paste, white of egg, two prawns, prop roots of *Pandanus odoratissimus* L.f. is kept overnight and applied externally on fractured bones by Kurichiar people of Kerala (Udayan et al. 2008). Fruits are considered spasmolytic (Khare 2007) while leaves are used for relieving muscular pain by people of Tamil Nadu (Ganesan et al. 2009).

Snake Bites

Leaves are also implicated against stings and bites of poisonous animals (Sierra et al. 2005). The Nicobarese people of Car Nicobar Island, India use leaves to cure snake bites (Chander et al. 2014) whereas the people of Kerala and Karnataka apply powder prepared from the whole plant (Subrahmanya 2012).

CONCLUSIONS

The traditional knowledge regarding the medicinal uses of Kamala tree is being documented from the Indian subcontinent, but information from other South Asian countries is poorly represented in the literature. About 70% of the total articles mentioned the utility of the tree for helminthic infestations, dermatological and digestive disorders suggesting that the tree may have some active chemicals that are effective for treating these health ailments. Also, more than 90% of informants cited the use of this tree for various ailments belonging to these three categories. While, other disorders such as excretory, psychological and skeletal disorders are less reported indicating that either these usages are not extensively explored or the trees are less effective against these disorders. Furthermore, almost all the components of the tree are utilised for one or more therapeutic applications, but fruits known as Kamala are exclusively used for the helminthic infestations and skin problems.

Interestingly, few studies reported that some local communities use to treat some diseases such as cancer, tuberculosis, kidney-stones using preparations from this plant but it is questionable that how the local people identify such diseases that cannot be diagnosed externally. Further, some of the studies reporting medicinal uses lack of exact dosage and preparations, which have no meaning to science. Therefore, future ethnobotanical research needs to report dosage, formulations and their use as exact as possible, rather than reporting inadequate information. Also, the available information about traditional uses is relatively less represented in literature as compared to diversity and area covered by different ethnic groups. Hence, this suggests that many ethnic communities and geographical areas are not documented yet and there is a scope of further exploration and documentation of such information.

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DATA AVAILABILITY

All the data used to support the findings of this study are available in the Additional File 1.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived the presented idea: ANS, RCB, NKS, RK.

Carried out the literature survey: AK, MP, PK.

Carried out the data analysis: AK, MP.

Wrote the first draft of the manuscript: NKS, RK, RCB.

Review: PK, RCB, RK, NKS, ANS.

Wrote the final manuscript: AK, MP, PK.

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ADDITIONAL FILE 1

List of selected studies for the present review

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Table 1. Major medicinal uses of *Mallotus philippensis* (Lam.) Müll. Arg. Number in parenthesis indicates the actual number of local respondents who cited the particular usage in the study. The number of citations indicates the total number of informants that cited a particular use in a respective study. We have considered the number of informants as one for studies which have not provided the actual number of local respondents whereas for studies that provided the actual number of respondents the total number of citations is considered as actual respondents plus one.

Disease Category	Disease	Part used	No. of citations	Mode of preparation, Dosage and Use	References
Dermatological disorders	Leprosy	Fruits	1	The fruit powder from pericarp is taken with other suitable drugs is effective for relieving leprous affections	(Usmanghani et al. 1997)
		Fruits	1	Fresh fruits are eaten directly	(Gupta et al. 2018)
	Skin ailments	Bark	15	A paste prepared from the bark is applied on burnt skin (14)	(Kosalge and Fursule 2009)
		Bark and leaves	1	Bark and leaf powder mixed with butter is applied on sores and boils	(Verma and Chauhan 2007)
		Bark and leaves	9	A paste prepared from bark and leaves is externally applied for skin diseases (8)	(Rashid et al. 2015)
		Fruits	1	The fruit powder after adding in suitable oil is used for skin irritation, ringworm and wounds. The red colour powder is used as ointment for ringworm, freckles and pityriasis and also applied over syphilitic ulcers	(Usmanghani et al. 1997)
		Fruits	1	Fruit powder is useful for cutaneous affections	(Siva 2007)
		Fruits	1	Fruits are styptic and fruit hairs are used for scabies	(Khare 2007)
		Fruits	1	Red fruit powder mixed with *ghee* (clarified butter) and applied on boils and blisters	(Nayak et al. 2004)
		Fruits	11	A paste prepared by mixing fruit powder with *ghee* (clarified butter) is externally applied on boils (10)	(Sharma et al. 2013)
		Fruits	1	Red powder from fruit pericarp is mixed with mustard oil and applied externally twice a day for skin diseases until the cure	(Panthi and Singh 2013)
		Fruits	4	Fine paste prepared by grinding fruits along with rhizome of *Curcuma longa* L. for is styptic (3)	(Bhatia et al. 2014)
		Fruits	1	Fruit powder is applied externally on skin itches and scabies	(Joshi and Joshi 2007)

		Fruits	27	An ointment prepared by mixing fruits in coconut oil is used for skin itching	(Kumar and Bharati 2014)
		Leaves	4	Crushed leaves are directly applied on boils and ringworms (3)	(Abbasi et al. 2010b)
		Leaves	9	The juice of leaves is applied topically on cuts and wounds (8)	(Sharma et al. 2014)
		Leaves	1	A cold decoction of leaves for skin infections	(Panda et al. 2018)
		Leaves	1	Leaves are useful for skin diseases	(Singh and Singh 2009)
		Seeds	1	A mixture prepared from seed powder of Kamala, Sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil is applied externally on skin affected areas with dermatitis	(Khan and Chaghtai 1982)
		Whole plant	1	A paste of stem bark, root bark, fruits or seeds are applied externally on infected skins	(Reddy 1995)
		Whole Plant	1	Plant powder is used for skin diseases	(Reddy 1996)
	Wounds	Bark	1	A paste of the bark is applied for wounds to stop bleeding	(Kamble et al. 2010)
		Fruits	1	Red fruit powder mixed with coconut oil is used for skin diseases and blisters of the ears	(Shukla et al. 2010)
		Fruits	8	Fruits are used for wounds (7)	(Gupta et al. 2018)
		Leaves	1	Leaf paste is applied on wounds	(Sharma et al. 2010)
		Seeds	1	A paste prepared from ground seeds is used for wounds and cuts	(Das et al. 2006)
		Seeds	1	Dried seed powder is applied on wounds	(Bharati and Sharma 2010)
		Seeds	1	Crushed seeds are applied externally to cure wound, injuries and skin infection in animals	(Bharati and Sharma 2012)
		Whole plant	1	Plant powder is used for wound healing	(Aziz et al. 2017)
Digestive disorders	Abdominal diseases	Bark	1	A decoction of the bark is useful for abdominal pain	(Das et al. 2006)
		Bark	1	A decoction of stem bark is used for abdominal pain	(Singh and Singh 2009)
		Bark	1	The bark is chewed and watery juice is swallowed internally for abdominal pain	(Hamayun et al. 2005)
		Fruits	1	Fruits are useful for abdominal diseases	(Ahmad et al. 2009)
		Leaves	1	A cold decoction of leaves is used for abdominal pain	(Panda et al. 2018)
	Appetiser	Leaves	1	Leaves are appetiser	(Nayak et al. 2004)
	Constipation	Fruits	1	Fruit extract is given orally for constipation	(Reddy 1995)

		Fruits	1	Red fruit powder is taken orally for constipation	(Nayak et al. 2004)
		Fruits	1	Fruits are used for constipation	(Malik et al. 2015)
		Fruits and bark	1	Fruits and bark are used to relieve constipation	(Sierra et al. 2005)
		Seeds	1	Dried seed powder mixed with a half cup of curd is given thrice a day for 1-2 days to relieve constipation	(Abbasi et al. 2010a)
		Seeds	1	A decoction of seeds is taken twice a day before food	(Pattanaik et al. 2006)
		Whole plant	1	The whole plant can be used for constipation	(Saqib et al. 2014)
	Diabetes	Fruits	1	A decoction is prepared by boiling a few fruits of *Mallotus philippensis* (Lam.) Müll. Arg. and seeds of *Syzygium cuminii* (L.) Skeels in about 200 ml of cow's milk. The decoction so obtained is taken twice a day for a period of about one month to treat diabetes	(Maruthupandian et al. 2011)
		Fruits	10	Useful for diabetes (9)	(Seethapathy et al. 2018)
		Fruits	1	Fruits are hypoglycaemic	(Khare 2007)
		Seeds	1	Red powder from seeds is taken internally once a day for lowering blood glucose level	(Poonam and Singh 2009)
	Diarrhoea and dysentery	Bark	1	3 spoonful of bark juice is taken thrice a day for diarrhoea and dysentery until the cure	(Taylor et al. 1996a)
		Bark	1	About 3-4 teaspoonfuls of bark juice (about 50 g bark crushed in 10 teaspoonful water) are taken 3 times a day for 7 days to treat diarrhoea and dysentery	(Mahato and Chaudhary 2005)
		Bark	1	Bark juice is drunk for diarrhoea	(Ghimire and Bastakoti 2009)
		Bark	1	Bark juice is used for diarrhoea and dysentery	(Acharya and Acharya 2010)
		Fruits	1	Red fruit powder is taken orally for dysentery	(Nayak et al. 2004)
		Fruits	1	Crushed fruits are taken orally for bloody diarrhoea	(Ahmed et al. 2013)
		Fruits	20	Fruits are taken orally for diarrhoea (19)	(Barkatullah et al. 2015)
	Flatulence	Leaves	1	Leaves are carminative	(Gupta 2015)
		Leaves	9	A decoction of leaves is carminative (8)	(Rashid et al. 2015)
	Indigestion	Bark	1	About 3 teaspoons of bark juice are taken orally four times a day	(Manandhar 1998)
	Jaundice	Seeds	1	Tablets prepared from shade dried seeds are taken with cold water for Jaundice	(Verma and Chauhan 2007)

		Seeds	1	Dried seed powder is made into tablets and given orally with cold water	(Sharma et al. 2012a)
	Purgation	Fruits	1	Fruits are purgative	(Ahmad et al. 2009; Sher et al. 2011)
		Seeds	1	Red powder from seeds is taken internally once a day for purgation	(Poonam and Singh 2009)
	Stomach disorders	Bark and leaves	1	A decoction of stem bark and leaf is taken with the stem bark of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr., root bark of *Phyllanthus emblica* L. and fruit of *Phoenix dactylifera* L. to cure stomach ache	(Ayyanar and Ignacimuthu 2005)
		Bark and leaves	10	Useful for stomach pain (9)	(Seethapathy et al. 2018)
		Bark	1	Bark juice is drunk for gastric disorders	(Ghimire and Bastakoti 2009)
		Fruits	1	Red fruit powder mixed with water is taken for a week to cure colic pain and expel bile	(Das et al. 2006)
		Fruits	1	Fruit powder is taken with jaggery in the early morning for stomach ache.	(Dahare and Jain 2010)
		Leaves	1	The paste is prepared from leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., bark of *Cinnamomum verum* J. Presl, camphor (terpenoid from *Cinnamomum camphora* (L.) J. Presl), fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., fruit of *Ficus scandens* Lam., clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, fruit of *Amomum subulatum* Roxb., fruit of *Amomum aromaticum* Roxb., fruit of *Piper longum* L., rhizome of *Curcuma zedoaria* Roxb., top of stem with leaf of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal. This paste is dried and converted into tablets which are taken orally for indigestion and stomach disorders	(Ahmed et al. 2017)
		Seeds	1	Seed decoction is drunk for Stomach ache	(Uprety et al. 2011)
		Whole plant	1	A paste prepared from powder of this plant mixed with roots of *Saccharum spontaneum* L., fruit powder/paste of *Piper longum* L., root juice of *Tinospora cordifolia* (Willd.) Miers and root juice of *Cheilanthes dalhosiae* Hook. is used for stomach ache	(Uprety et al. 2011)

Excretory disorders	Urinary infections	Fruits and seeds	1	A paste prepared from fruits and seeds is diluted and taken orally for urinary disorders	(Nayak et al. 2004)
		Fruits	1	Fruit paste is taken internally for urinary infections	(Panda 2014)
Helminthic infestations	Intestinal worms of animals	Fruits	1	Fruits are anthelmintic for Goats	(Akhtar and Ahmad 1992)
		Fruits	1	About 5 g of fruit powder is given orally to animals infected with intestinal worms	(Davis et al. 1995)
		Fruits	4	100–200 g fruits drenched with 500 g of yoghurt is given to animals for intestinal worms (3)	(Farooq et al. 2008)
		Fruits	4	10 g of fruits with 125 g of yoghurt is given orally to equines (3)	(Goraya et al. 2013)
		Fruits	57	Mix the 10 g fruit powder with 0.5 L of milk and administer orally (56)	(Hussain et al. 2008)
		Fruits	42	Mix the 4 drams (1 dram = 1.77 g) fruit powder with 0.5 kg of curd and administer orally (41)	(Hussain et al. 2008)
		Fruits	18	Mix the 4 drams fruit powder with 0.5 L of milk whey and administer orally (17)	(Hussain et al. 2008)
		Fruits	2	10 g fruits in 250 ml milk whey are administered orally to equines (1)	(Goraya et al. 2013)
		Fruits	13	Mix the 4 drams fruit powder with 0.5 L of mustard oil and administer per os (12)	(Hussain et al. 2008)
		Fruits	4	Grind the 10 g fruit powder with jaggery and administer per os (3)	(Hussain et al. 2008)
		Fruits	9	Mix the 50 g fruit powder with 0.5 L of water and administer per os (8)	(Hussain et al. 2008)
		Fruits	6	Grind about 10 g fruits of *Mallotus philippensis* (Lam.) Müll. Arg., 10 g fruits of *Tamarix aphylla* (L.) H. Karst. and seeds of *Brassica campestris* L., 0.5 L of mustard oil, 0.5 kg of curd and administer per os (5)	(Hussain et al. 2008)
		Fruits	2	60 g seeds of *Linum usitatissimum* L., 60 g seeds of *Lepidium sativum* L. and 25 g fruits of *Mallotus philippensis* are given orally to equines with 250 g of Jaggery (1)	(Goraya et al. 2013)
		Fruits	20	50–100 g fruits are given with jaggery per os to ruminant animals (19)	(Jabbar et al. 2006)

		Fruits	7	50 g fruits with 250 g jaggery are given orally to equines (6)	(Goraya et al. 2013)
		Fruits	73	Fruit powder mixed with curd is fed to animals for internal parasites (72)	(Sharma et al. 2012b)
		Fruits	10	Fruits are taken orally for helminthic infestations (9)	(Sharma and Manhas 2015)
		Fruits	5	Ground fruit is mixed with curd and fed to animals for the expulsion of internal parasites (4)	(Bhatia et al. 2014)
		Fruits	1	Fruit powder along with wheat flour is given to animals for 2–3 days to cure intestinal worms	(Kumar and Nagayya 2017)
		Fruits	22	250 g fruit powder with wheat flour is given to cow, goat and sheep for intestinal worms (21)	(Abbasi et al. 2013)
		Seeds	1	About 50 g seeds are given to pigs with food to kill intestinal worms	(Bharati and Sharma 2012)
	Intestinal worms of Human beings	Flower	1	A flower decoction is given for the expulsion of tapeworms	(Yesodharan and Sujana 2007)
		Fruits	1	Fruits boiled with common salt are taken for killing intestinal worms	(Jain and Puri 1984)
		Fruits	1	About 10 ml of fruit decoction is given to children for killing worms of the intestine	(Chakraborty and Bhattacharjee 2006)
		Fruits	1	The crude red fruit powder is used to kill threadworm, roundworm and hookworm	(Das et al. 2006)
		Fruits	1	Fruit powder is taken with milk or curd to remove intestinal worms of children	(Shanmugam et al. 2009)
		Fruits	3	Fruits are eaten orally for killing stomach-worms (2)	(Rao et al. 2015)
		Leaves	9	A decoction of leaves is used as anthelmintic (8)	(Rashid et al. 2015)
		Seeds	1	Dried seed powder mixed with a half cup of curd is given thrice a day for 1-2 days to kill intestinal worms	(Abbasi et al. 2010a)
		Seeds	1	Seed powder is taken with cold water to expel intestinal worms	(Singh et al. 2014)
		Whole plant	1	A powder prepared from dried fruits, leaves, stem and bark is eaten to cure tapeworms	(Ghimire and Bastakoti 2009)
		Whole plant	122	The whole plant can be used for intestinal worms (121)	(Saqib et al. 2014)
Inflammatory	Fever	Leaves	1	The paste is prepared from leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., bark of *Cinnamomum verum* J. Presl, camphor	(Ahmed et al. 2017)

				(terpenoid from *Cinnamomum camphora* (L.) J. Presl), fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., fruit of *Ficus scandens* Lam., clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, fruit of *Amomum subulatum* Roxb., fruit of *Amomum aromaticum* Roxb., fruit of *Piper longum* L., rhizome of *Curcuma zedoaria* Roxb., top of stem with leaf of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal. This paste is dried and converted into tablets which are taken orally for fever, puerperal fever and pneumonia.	
		Whole plant	1	A powder prepared from dried fruits, leaves, stem and bark is eaten to typhoid fever	(Ghimire and Bastakoti 2009)
	Headache	Leaves	1	Toasted leaves are applied externally for headache	(Zheng et al. 2013)
	Rheumatism	Bark	1	Bark decoction is used for rheumatism	(Subrahmanya 2012)
		Leaves	1	Leaf decoction is taken for *Vat Rog* (rheumatism)	(Verma and Chauhan 2007)
		Leaves and fruits	1	A paste is prepared by mixing an equal amount of leaves and tender fruits in honey. This paste is taken twice a day for 13 days to get relief from rheumatism	(Sutha et al. 2010)
		Roots	1	Among the Mundas people of Chota Nagpur, well ground roots are rubbed on the rheumatic joints	(Kirtikar and Basu 1935)
		Roots	1	Root-bark for arthritis and rheumatism	(Biswas 2012)
		Seeds	1	A mixture prepared from seed powder of *Mallotus philippensis* (Lam.) Müll. Arg., sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil is applied externally on rheumatic joints	(Khan and Chaghtai 1982)
		Seeds	1	Seed paste is applied on rheumatic joints	(Reddy 1995)
	Meningitis	Bark	1	Bark juice is drunk for meningitis	(Ghimire and Bastakoti 2009)
	Spleen enlargement	Fruits	1	About 10 ml of fruit decoction is given to children for an enlarged spleen	(Chakraborty and Bhattacharjee 2006)
Microbial infections	Bacterial infections	Bark	1	The bark is used as antibiotic	(Taylor et al. 1996a)
	Cold	Leaves	1	Oil prepared from leaves is applied on head for cold and running noses	(Subrahmanya 2012)

		Fruits and leaves	1	Fruits and leaves are used for cold	(Sierra et al. 2005)
	Polio	Roots	1	Small and thin roots are tied around the neck	(Verma and Chauhan 2007)
	Viral infections	Bark	1	The bark is effective against viral infections	(Taylor et al. 1996b)
Skeletal	Bone fractures	Bark	1	A mixture of bark paste, the white part of egg, two prawns, prop roots of *Pandanus odoratissimus* L.f. is kept overnight and applied externally on fractured bones. Sometimes this paste is tied with cloth along with bamboo splints	(Udayan et al. 2008)
	Spasmolytic	Fruits	1	Fruits are useful spasmolytic	(Khare 2007)
		Leaves	1	Leaves are used for muscle pain	(Ganesan et al. 2009)
		Seeds	1	Red powder from seeds is taken internally once a day for relieving muscle spasm	(Poonam and Singh 2009)
Psychological	Cathartic	Fruits	1	Fruits have cathartic properties	(Khare 2007; Usmanghani et al. 1997)
	Dizziness	Leaves	1	A paste prepared by crushing fresh leaves in hen's egg is applied on eyes for vertigo	(Jagtap et al. 2006)
Reproductive	Hydrocele	Bark and leaves	1	A decoction of stem bark and leaf is taken with the stem bark of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr., root bark of *Phyllanthus emblica* L. and fruit of *Phoenix dactylifera* L. to cure hydrocele	(Ayyanar and Ignacimuthu 2005)
	Leucorrhoea	Leaves	4	A curry prepared from leaf buds eaten for leucorrhoea (3)	(Shil et al. 2014)
		Leaves	1	A curry prepared by mixing the leaf buds with hen's egg is taken internally for leucorrhoea	(Shil and Choudhury 2009)
		Leaves	1	The paste is prepared from leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., bark of *Cinnamomum verum* J. Presl, camphor (terpenoid from *Cinnamomum camphora* (L.) J. Presl), fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., fruit of *Ficus scandens* Lam., clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, fruit of *Amomum subulatum* Roxb., fruit of *Amomum aromaticum* Roxb., fruit of *Piper longum* L., rhizome of *Curcuma zedoaria* Roxb., top of stem with leaf	(Ahmed et al. 2017)

				of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal. This paste is dried and converted into tablets taken orally for fever, puerperal fever and pneumonial fever	
		Roots	4	Boiled roots are taken orally for leucorrhoea (3)	(Khuankaew et al. 2014)
	Menstrual disorders	Fruits	1	Fruit paste is taken	(Panda 2014)
		Fruits and seeds	1	A paste prepared from fruits and seeds is diluted and taken orally for menstrual disorders	(Nayak et al. 2004)
		Leaves	1	Juice is prepared by crushing leaves of *Mallotus philippensis* (Lam.) Müll. Arg., leaves of *Rungia pectinata* (L.) Nees. and fruits of *Piper longum* L. About half cup of this juice is taken for 4-5 days to regularize un-periodic menstruation	(Patil and Patil 2004)
	Uterine infections	Leaves	1	The paste is prepared from leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., bark of *Cinnamomum verum* J. Presl, camphor (terpenoid from *Cinnamomum camphora* (L.) J. Presl), fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., fruit of *Ficus scandens* Lam., clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, fruit of *Amomum subulatum* Roxb., fruit of *Amomum aromaticum* Roxb., fruit of *Piper longum* L., rhizome of *Curcuma zedoaria* Roxb., top of stem with leaf of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal. This paste is dried and converted into tablets which are taken orally for uterine infections and associated fever	(Ahmed et al. 2017)
Respiratory	Asthma	Roots	4	Boiled roots are taken orally for allergic asthma (3)	(Khuankaew et al. 2014)
	Bronchitis	Bark	2	Bark juice is used for bronchitis	(Acharya and Acharya 2010; Ghimire and Bastakoti 2009)
	Chest problems and Tuberculosis	Fruits	8	Fruits are eaten for chest problems and Tuberculosis (7)	(Gupta et al. 2018)

		Bark	2	A decoction of the bark is taken orally for cough (1)	(Zheng and Xing 2009)
		Leaves	1	Leaf powder is given for cough	(Sharma et al. 2010)
Snake bite	Snake bites	Leaves	2	Leaves are used for snake bites (1)	(Chander et al. 2014)
		Fruits and leaves	1	The fruits and leaves are used against stings (poisonous insects and animals) and bites of snakes and other poisonous animals	(Sierra et al. 2005)
		Whole plant	1	A powder prepared from leaves, bark and fruits is used	(Subrahmanya 2012)

Table 2. The formulations prepared from *Mallotus philippensis* (Lam.) Müll. Arg. vary among different ethnic groups.

Ethnic groups	Formulations	Reference
Abbasies, Awans, Jadoon, Mashwani, Sardars, Sheikhs, Syeds, Tanolis, Tareen, Qureshis of Abbottabad, North-West Frontier Province, Pakistan	Dried seed powder mixed with a half cup of curd is given thrice a day for 1-2 days to relieve constipation and kill intestinal worms	(Abbasi et al. 2010a)
Baiga, Bhariya, Bhumiya, Gond and *Panka* tribes of Madhya Pradesh, India	Fresh fruits are eaten directly for leprosy, wounds, chest problems and Tuberculosis	(Gupta et al. 2018)
Bhilla tribe of Maharashtra, India	A paste of the bark is applied for wounds to stop bleeding	(Kamble et al. 2010)
Bhils, Kokana, Kokana-Kunbi, Katkaris, Mahadeo Koil, Thakur and *Warli* of Nasik, Maharashtra, India	Juice is prepared by crushing leaves of *Mallotus philippensis* (Lam.) Müll. Arg., leaves of *Rungia pectinata* (L.) Nees. and fruits of *Piper longum* L. About half cup of this juice is taken for 4-5 days to regularize un-periodic menstruation	(Patil and Patil 2004)
Bhumijs, Birhores, Kherias, Lodhas, Mundas, Oraons, Paharias and *Santals* of Purulia, West Bengal, India	About 10 ml of fruit decoction is given to children for killing worms of the intestine and enlarged spleen	(Chakraborty and Bhattacharjee 2006)
Bhutias, Lepchas, Limbus and *Nepalese* of Sikkim, India	Crushed seeds are applied externally to cure wound, injuries and skin infection in animals. About 50 g seeds are given to pigs with food to kill intestinal worms	(Bharati and Sharma 2010, 2012)
Adivasi, Bodo, Nepali and *Rajbanshis* of Chirang Reserve Forest, Assam, India	A cold decoction of leaves for skin infections and abdominal pain	(Panda et al. 2018)
Farmers and equine Owners of Punjab, Pakistan	About 10 g of fruits with 125 g of yoghurt is given orally to equines. About 60 g seeds of *Linum usitatissimum* L., 60 g seeds of *Lepidium sativum* L. and 25 g fruits of *Mallotus philippensis* (Lam.) Müll. Arg. are given orally to equines with 250 g of Jaggery. About 50 g fruits with 250 g jaggery are given orally to equines	(Goraya et al. 2013)
Garo tribal of Haluaghat, Mymensingh, Bangladesh	The paste is prepared from leaves of *Mallotus philippensis* (Lam.) Müll. Arg., tubers of *Colocasia esculenta* (L.) Schott., bark of *Cinnamomum verum* J. Presl, camphor (terpenoid from *Cinnamomum camphora* (L.) J. Presl, fruit of *Piper cubeba* L.f., leaf of *Scoparia dulcis* L., fruit of *Ficus scandens* Lam., clove of *Syzygium aromaticum* (L.) Merr. & L. M. Perry, fruit of *Amomum subulatum*	(Ahmed et al. 2017)

	Roxb., fruit of *Amomum aromaticum* Roxb., fruit of *Piper longum* L., rhizome of *Curcuma zedoaria* Roxb., top of stem with leaf of *Bambusa tulda* Roxb., leaf pulp of *Aloe vera* (L.) Burm.f., rhizome of *Alpinia nigra* (Gaertn.) Burtt, and calcined copper, lead, iron, brass, any colour and bell metal. This paste is dried and converted into tablets which are taken orally for indigestion and stomach disorders, fever, puerperal fever and pneumonia, uterine infections and associated fever	
Agaria, Baiga, Gond, Khaiwar, Kol, Manjhi, Mawasi and *Panica* of Rewa, Madhya Pradesh, India	Red fruit powder mixed with coconut oil is used for skin diseases and blisters of the ears	(Shukla et al. 2010)
Gujjars of Malakand Pass Hills, Khyber Pakhtunkhwa, Pakistan	Fruits are taken orally for diarrhoea	(Barkatullah et al. 2015)
Gujjars of Dehradun, Haridwar, Pauri and Udham Singh Nagar, Uttarakhand, India	A paste prepared by mixing fruit powder with *ghee* (clarified butter) is externally applied on boils	(Sharma et al. 2013)
Herdsmen of Punjab, Pakistan	50–100 g fruits are given with jaggery *per os* to ruminant animals	(Jabbar et al. 2006)
Indigenous communities/traditional healers of Bajaur Agency, Federally Administrated Tribal Areas, Pakistan	Plant powder is used for wound healing	(Aziz et al. 2017)
Indigenous people of Azad Jammu and Kashmir, Pakistan	A decoction of leaves is carminative and anthelmintic	(Rashid et al. 2015)
Indigenous people of Bhopal, India	A mixture prepared from seed powder of *Mallotus philippensis* (Lam.) Müll. Arg., sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil is applied externally on rheumatic joints	(Khan and Chaghtai 1982)
Indigenous people of Cuddapah, Andhra Pradesh, India	Seed paste is applied on rheumatic joints	(Reddy 1995)
Indigenous People of Garo Hills, Nokrek Biosphere Reserve (Meghalaya), India	Seed powder is taken with cold water to expel intestinal worms	(Singh et al. 2014)
Indigenous people of Hassan district, Karnataka, India	Fruit powder along with wheat flour is given to animals for 2–3 days to cure intestinal worms	(Kumar and Nagayya 2017)

Indigenous people of India	Fruits and bark are used to relieve constipation. Fruits and leaves are used for cold. The fruits and leaves are used against stings (poisonous insects and animals) and bites of snakes and other poisonous animals	(Sierra et al. 2005)
Indigenous people of India, Pakistan	Fruits have cathartic properties	(Khare 2007; Usmanghani et al. 1997)
Indigenous people of Jaunsar-Bawar, Uttarakhand, India	Fruits boiled with common salt are taken for killing intestinal worms	(Jain and Puri 1984)
Indigenous people of Kathua, Jammu and Kashmir, India	Fruits are eaten orally for killing stomach-worms	(Rao et al. 2015)
Indigenous people of Kathua, Jammu and Kashmir, India	Fruit powder mixed with curd is fed to animals for internal parasites	(Sharma et al. 2012b)
Indigenous People of Kerala and Karnataka, India	Bark decoction is used for rheumatism. Oil prepared from leaves is applied on head for cold and running noses. A powder prepared from leaves, bark and fruits is used.	(Subrahmanya 2012)
Indigenous people of Kunihar, Solan, Himachal Pradesh, India	Tablets prepared from shade dried seeds are taken with cold water for Jaundice. Leaf decoction is taken for Vat Rog (rheumatism). Small and thin roots are tied around the neck	(Verma and Chauhan 2007)
Indigenous people of Malkangiri, Orissa	Root-bark for arthritis and rheumatism	(Biswas 2012)
Indigenous people of Pallapatty, Madurai, Tamil Nadu, India	Leaves are used for muscle pain	(Ganesan et al. 2009)
Indigenous people of Patriata, Rawalpindi, Pakistan	Crushed fruits are taken orally for bloody diarrhoea	(Ahmed et al. 2013)
Indigenous people of Sirohi, Rajasthan, India	Leaves are carminative	(Gupta 2015)
Indigenous people of Udhampur, Jammu and Kashmir, India	Ground fruit is mixed with curd and fed to animals for the expulsion of internal parasites	(Bhatia et al. 2014)
Indigenous people of Arghakhanchi, Nepal	Red powder from fruit pericarp is mixed with mustard oil and applied externally twice a day for skin diseases until the cure	(Panthi and Singh 2013)

Indigenous people of Azad Jammu and Kashmir, Pakistan	A paste prepared from bark and leaves is externally applied for skin diseases	(Rashid et al. 2015)
Indigenous people of Bhopal, India	A mixture prepared from seed powder of Kamala, Sulphur, sawdust of *Dalbergia sissoo* DC. and sandalwood oil is applied externally on skin affected areas with dermatitis	(Khan and Chaghtai 1982)
Indigenous people of Cuddapah, Andhra Pradesh, India	A paste of stem bark, root bark, fruits or seeds are applied externally on infected skins. Fruit extract is given orally for constipation.	(Reddy 1995)
Indigenous people of Cuddapah, Andhra Pradesh, India	Plant powder is used for skin diseases	(Reddy 1996)
Indigenous people of district Buner, North-West Frontier Province, Pakistan	The bark is chewed and watery juice is swallowed internally for abdominal pain	(Hamayun et al. 2005)
Indigenous people of Kunihar, Solan, Himachal Pradesh, India	Bark and leaf powder mixed with butter is applied on sores and boils	(Verma and Chauhan 2007)
Indigenous people of Margalla Hills National Park, Islamabad, Pakistan	Fruits are useful for abdominal diseases	(Ahmad et al. 2009)
Indigenous people of Udhampur, Jammu and Kashmir, India	Fine paste prepared by grinding fruits along with rhizome of *Curcuma longa* L. for is styptic	(Bhatia et al. 2014)
Kani/Kanikaran community of Kouthalai of Tirunelveli hills, Tamil Nadu, India	A decoction of stem bark and leaf is taken with the stem bark of *Madhuca longifolia* (J. Koenig ex L.) J. F. Macbr., root bark of *Phyllanthus emblica* L. and fruit of *Phoenix dactylifera* L. to cure stomach ache and hydrocele	(Ayyanar and Ignacimuthu 2005)
Kanikkar community of Kalakad-Mundanthurai Tiger Reserve, Tamil Nadu, India	A paste is prepared by mixing an equal amount of leaves and tender fruits in honey. This paste is taken twice a day for 13 days to get relief from rheumatism	(Sutha et al. 2010)
Dhobhi, *Kevat*, *Kharwas* and *Polekero* of Chandauli, Uttar Pradesh, India	Leaves are useful for skin diseases. A decoction of stem bark is used for abdominal pain	(Singh and Singh 2009)
Ghassi, Jatapu, Jhodia, Konda Dora, Kondhas, Kotia kondha, Relli and *Souras* of Rayagada, Orissa, India	A decoction of seeds is taken twice a day before food	(Pattanaik et al. 2006)

	The crude red fruit powder is used to kill threadworm, roundworm and hookworm	
Bhoxa, nomadic *Gujjars* and *Tharu* of Dehradun, Haridwar, Pauri and Udham Singh Nagar, Uttarakhand, India	Dried seed powder is made into tablets and given orally with cold water	(Sharma et al. 2012a)
Palliyar tribes of Virudhunagar, Tamil Nadu, India	Fruit powder is taken with milk or curd to remove intestinal worms of children	(Shanmugam et al. 2009)
Palliyar tribals of Sirumalai hills, Western Ghats, Tamil Nadu, India	A decoction is prepared by boiling a few fruits of *Mallotus philippensis* (Lam.) Müll. Arg. and seeds of *Syzygium cuminii* (L.) Skeels in about 200 ml of cow's milk. The decoction so obtained is taken twice a day for a period of about one month to treat diabetes	(Maruthupandian et al. 2011)
Pashtun Koochi nomads of Afghanistan	About 5 g of fruit powder is given orally to animals infected with intestinal worms	(Davis et al. 1995)
Pastoral nomads of Cholistan desert, Pakistan	About 100–200 g fruits drenched with 500 g of yogurt is given to animals for intestinal worms	(Farooq et al. 2008)
Pawara tribe of Satpuda Hills, Madhya Pradesh, India	A paste prepared from the bark is applied on burnt skin	(Kosalge and Fursule 2009)
Jhadia, Kandha, Kutia, Praja and *Tekeria* of Kalahandi, Odisha, India	Leaves are appetiser. Red fruit powder is taken orally for constipation and dysentery. A paste prepared from fruits and seeds is diluted and taken orally for urinary and menstrual disorders. Red fruit powder mixed with *ghee* (clarified butter) and applied on boils and blisters	(Nayak et al. 2004)
Raute tribe of Dadeldhura district, Nepal	About 3 teaspoons of bark juice are taken orally four times a day	(Manandhar 1998)
Reang tribe of Dhalai, Tripura, India	A curry prepared by mixing the leaf buds with hen's egg is taken internally for leucorrhoea	(Shil and Choudhury 2009)
Reang tribe of Tripura, India	A curry prepared from leaf buds eaten for leucorrhoea	(Shil et al. 2014)
Run and *Qi* of *Li* ethnic group of Hainan Island, China	A decoction of the bark is taken orally for cough	(Zheng and Xing 2009)
Baiga, Bathudi, Bhumij, Gond, Kisan, Kolha, Lodha, Mankidia, Munda and *Santal* of Similipal Biosphere Reserve, Odisha, India	Fruit paste is taken internally for urinary infections	(Panda 2014)

Dhanials, Dhunds, Kethwals and *Satties* of Kotli Sattian, Rawalpindi, Pakistan	The whole plant can be used for constipation and intestinal worms	(Saqib et al. 2014)
Abbasi, *Awan*, *Ghakar*, *Gujjar*, *Jadoon*, *Karaal*, *Syed* and *Tanoli* of Khyber Pakhtunkhwa (KPK) province, Pakistan	About 250 g fruit powder with wheat flour is given to cow, goat and sheep for intestinal worms	(Abbasi et al. 2013)
Tai Yai people of Thailand	Boiled roots are taken orally for allergic asthma and leucorrhoea	(Khuankaew et al. 2014)
Taungya community of Gorakhpur and Maharajganj, Uttar Pradesh, India	Red powder from seeds is taken internally once a day for lowering blood glucose level, purgation and relieving muscle spasm.	(Poonam and Singh 2009)
Tharu community of Dudhwa National Park, Uttar Pradesh, India	An ointment prepared by mixing fruits in coconut oil is used for skin itching	(Kumar and Bharati 2014)
Tharu community of Nawalparasi, Nepal	Bark juice is drunk for diarrhoea, meningitis and gastric disorders. A powder prepared from dried fruits, leaves, stem and bark is eaten to cure tapeworms and typhoid fever	(Ghimire and Bastakoti 2009)
Tharu community of Nepal	About 3 spoonful of bark juice is taken thrice a day for diarrhoea and dysentery until the cure	(Taylor et al. 1996a)
Tharu community of Nepal	The bark is used as antibiotic	(Taylor et al. 1996a)
Tharu community of Rupandehi and Nawalparasi district, Nepal	Bark juice is used for bronchitis	(Acharya and Acharya 2010; Ghimire and Bastakoti 2009)
Tharu community of Rupandehi district, Nepal	Bark juice is used for diarrhoea and dysentery	(Acharya and Acharya 2010)
Tharu community of Udham Singh Nagar, Uttarakhand, India	The juice of leaves is applied topically on cuts and wounds	(Sharma et al. 2014)
Chhetri, Magar, Newaris, Raute and *Tharu* people of Nepal	The bark is effective against viral infections	(Taylor et al. 1996b)
Traditional healers of Kali Gandaki, Bagmati and Tadi Likhu Watersheds of Nepal	Fruit powder is applied externally on skin itches and scabies	(Joshi and Joshi 2007)

Traditional healers of Kathua, Jammu and Kashmir, India	Fruits are taken orally for helminthic infestations	(Sharma and Manhas 2015)
Traditional healers of Kedarnath Wildlife Sanctuary, Uttarakhand, India	Fruits are used for constipation	(Malik et al. 2015)
Traditional healers of Palpa district, Nepal	About 3-4 teaspoonfuls of bark juice (about 50 g bark crushed in 10 teaspoonful water) are taken 3 times a day for 7 days to treat diarrhoea and dysentery	(Mahato and Chaudhary 2005)
Traditional healers of Shahjahanpur, Uttar Pradesh, India	Leaf powder is given for cough and Leaf paste is applied on wounds	(Sharma et al. 2010)
Traditional veterinary healers of Punjab, Pakistan	10 g fruits in 250 ml milk whey are administered orally to equines	(Goraya et al. 2013)
Traditional veterinary healers of Sahiwal district of Punjab, Pakistan	Mix the 10 g fruit powder with 0.5 L of milk and administer orally. Mix the 4 drams (1 dram = 1.77 g) fruit powder with 0.5 kg of curd and administer orally. Mix the 4 drams fruit powder with 0.5 L of milk whey and administer orally. Mix the 4 drams fruit powder with 0.5 L of mustard oil and administer *per os*. Grind the 10 g fruit powder with jaggery and administer *per os*. Mix the 50 g fruit powder with 0.5 L of water and administer *per os*. Grind about 10 g fruits of *Mallotus philippensis* (Lam.) Müll. Arg., 10 g fruits of *Tamarix aphylla* (L.) H. Karst. and seeds of *Brassica campestris* L., 0.5 L of mustard oil, 0.5 kg of curd and administer *per os*	(Hussain et al. 2008)
Various indigenous people of India	Fruits are hypoglycaemic, spasmolytic, styptic and fruit hairs are used for scabies	(Khare 2007)
Various indigenous people of India	Fruit powder is useful for cutaneous affections	(Siva 2007)
Various indigenous people of Pakistan	The fruit powder from pericarp is taken internally with other suitable drugs is effective for relieving leprous affections. The fruit powder after adding in suitable oil is used for skin irritation, ringworm and wounds. The red colour powder is used as ointment for ringworm, freckles and pityriasis and also applied over syphilitic ulcers	(Usmanghani et al. 1997)